Sean Conway, Minister
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Curriculum Guideline

Design and Technology

VALIDATION DRAFT

Draft document for discussion purposes

September 1989

Ministry of Education
Ontario
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DESIGN AND TECHNOLOGY

Design and Technology	Grades 7 - 12
Design Studies	Grades 9 - 12
Elements of Technology	Grades 9 - 12

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PREFACE

The growing importance of information technology to business and industry means that students who participate in technical literacy courses today require different types of skills and knowledge than students did in the past. The need for skills in the trades and service occupations continues, but there is a greater demand for knowledge and skills related to ever changing technologies. Therefore, the integration of design methodology and technical competency should prepare students for employment and post secondary education at the same time as it provides them with a basic understanding of modern technology.

The accelerated pace of change in contemporary life also requires students to develop a wide range of basic learning and job skills with the positive attitudes and feelings of self-worth that will allow them to adapt readily to changing employment requirements. These needs should be reflected in courses that are developed from this guideline.

This document supercedes and replaces Industrial Arts I. and S. 19, 1962.

INTRODUCTION

This document is designated as Module 1 for Design & Technology. It includes three subjects: Design and Technology, Design Studies and Elements of Technology.

Design and Technology will be the first formal technology course taken by many students, usually in elementary school. Design and Technology courses provide opportunities for students to discover and use creative abilities in projects that involve tools and materials.

Design Studies courses provide opportunities for students to identify, analyze and solve design problems involving products or systems that fill particular needs, and that have value in the marketplace.

Elements of Technology courses are broad based programs that provide a foundation in Communications, Construction, Manufacturing and Transportation technologies.

Courses from this guideline may also be taught as part of the Technological Studies Guideline, Part B7: Materials, Processes and Design.

Note: These courses may form part of a schools Contemporary Studies or Technological Studies program. The credits earned in these courses may, at the individual students' discretion, be used as (a) credits in contemporary studies, or (b) credits in technological studies. In addition, credits earned may be counted as those of the eight required for concentration in technological studies.

PART A - PROGRAM PLANNING

1. GOALS, AIMS AND OBJECTIVES

1.1 The Goals of Education

The goals of education for Ontario are stated in OSIS:

The Ministry of Education in Ontario strives to provide in the schools of the province equal opportunity for all. In its contribution to programs, personnel, facilities, and finances, the ministry has the overall purpose of helping individual learners to achieve their potential in physical, intellectual, emotional, social, cultural, and moral development. The goals of education, therefore, consist of helping each student to:

1. **Develop a responsiveness to the dynamic processes of learning**
   Processes of learning include observing, sensing, inquiring, creating, analyzing, synthesizing, evaluating, and communicating. The dynamic aspect of these processes derives from their source in many instinctive human activities, their application to real-life experiences, and their systematic interrelation within the curriculum.

2. **Develop resourcefulness, adaptability, and creativity in learning and living**
   These attributes apply to modes of study and inquiry, to the management of personal affairs such as career plans and leisure activities, and to the ability to deal effectively with challenge and change.

3. **Acquire the basic knowledge and skills needed to comprehend and express ideas through words, numbers, and other symbols**
   Such knowledge and skills will assist the learner in applying rational and intuitive processes to the identification and solution of problems by:
   a) using language aptly as a means of communication and an instrument of thought;
   b) reading, listening, and viewing with comprehension and insight;
   c) understanding and using mathematical operations and concepts.

4. **Develop physical fitness and good health**
   Factors that contribute to fitness and good health include regular physical activity, an understanding of human biology and nutrition, the avoidance of health hazards, and concern for personal well-being.

5. **Gain satisfaction from participating and from sharing the participation of others in various forms of artistic expression**

   Artistic expression involves the clarification and restructuring of personal perception and experience. It is found in the visual arts, music, drama, and literature, as well as in other areas of the curriculum in which both the expressive and receptive capabilities of the learner are being developed.

6. **Develop a feeling of self-worth**

   Self-worth is affected by internal and external influences. Internally it is fostered by realistic self-appraisal, confidence and conviction in the pursuit of excellence, self-discipline, and the satisfaction of achievement. Externally it is reinforced by encouragement, respect, and supportive evaluation.

7. **Develop an understanding of the role of the individual within the family and the role of the family within society**

   Within the family the individual shares responsibility, develops supportive relationships, and acquires values. Within society the family contributes to the stability and quality of a democratic way of life.

8. **Acquire skills that contribute to self-reliance in solving practical problems in everyday life**
These skills relate to the skilful management of personal resources, effective participation in legal and civic transactions, the art of parenthood, responsible consumerism, the appropriate use of community agencies and services, the application of accident-prevention techniques, and a practical understanding of the basic technology of home maintenance.

9. **Develop a sense of personal responsibility in society at the local, national, and international levels**
Awareness of personal responsibility in society grows out of knowledge and understanding of one's community, one's country, and the rest of the world. It is based on an understanding of social order, a respect for the law and the rights of others, and a concern for the quality of life at home and abroad.

10. **Develop esteem for the customs, cultures, and beliefs of a wide variety of societal groups**
This goal is related to social concord and individual enrichment. In Canada, it includes regard for:
a) the Native peoples;
b) the English and French founding peoples;
c) multiculturalism;

d) national identity and unity.

11. **Acquire skills and attitudes that lead to satisfaction and productivity in the world of work**
    In addition to the appropriate academic, technical, and interpersonal skills, this goal relates to good work habits, flexibility, initiative, leadership, the ability to cope with stress, and regard for the dignity of work.

12. **Develop respect for the environment and a commitment to the wise use of resources**
    This goal relates to a knowledgeable concern for the qualify of the environment. the careful use of natural resources, and the humane treatment of living things.

13. **Develop values related to personal, ethical, or religious beliefs and to the common welfare of society**
    Moral development in the school depends in part on a consideration of ethical principles and religious beliefs, a respect for the ideals held by others, and the identification of personal and societal values.

Education should also help each student to develop an awareness of those stereotypes and assumptions that contribute to the unequal position of women in contemporary society.

The preceding goals are not arranged in any hierarchical order, nor are they discrete categories from which a checklist should be made. The integrated nature of learning and the complex pattern of human development preclude such a sequential or fragmented approach. The translation of the goals into curriculum objectives, however, will undoubtedly result in sequences of learning appropriate to the particular levels and stages of development of the students for whom programs are being planned.[1]

1.2 The Aims of Design & Technology Courses

The following aims relate to the general goals of education for Ontario and focus specifically on the areas of learning associated with Design & Technology.

In design & technology courses, students shall be given the opportunity to:

1. **Develop the following understandings and attitudes:**
   - a respect for and co-operation with co-workers and supervisors in a simulated employment setting;
   - an awareness and practice of good safety habits through regular use of safety equipment and

[1] Ontario Schools, Intermediate and Senior Divisions, 1989, pp.3-4.

accident-prevention techniques in a practical work setting;

- a commitment to the responsible use and conservation of the sources of energy that provide the motive power for sustaining a technological society;
- an appreciation of the relationship between technological changes and the quality of life;
- an awareness of the nature and frequency of technological changes that affect career plans and the ability to adapt to these changes in an intelligent manner;
- an appreciation of the aesthetic component of design in addition to the basic functional component;
- an appreciation of the pride and satisfaction that may be found in quality work through practical project exercises;
- an awareness of the quality of goods and services through knowledge of processes and products, so that students may become educated consumers;

2. **Develop the following kinds of technological skills and knowledge:**
   - the ability to analyse and solve problems and to plan and perform tasks logically and effectively;
   - a capacity for clear and creative thinking and for inventiveness in the design and production of practical projects;

- the ability to produce, maintain, and repair objects of value through the development of competence in the use of hand tools, power tools, and machines related to home maintenance as well as to technological fields of interest;
- the ability to use the correct terminology and language in identifying machine parts and describing processes;
- personal and social skills that contribute to self-reliance and positive attitudes. Students should learn to organize their time effectively; to develop a routine for maintaining clean and neat work stations; to become accountable for identifying and storing tools; and to become aware of personal strengths through exploration and involvement in various technological fields;

3. **Prepare for entering:**
   - further education and the mastery of specific fields of technology and design;
   - employment, with marketable design methodology and technical competency and knowledge.

1.3 Student Objectives

Students may enrol in courses derived from this document for a variety of reasons. Many will be continuing a design and

technology program that began in Grade 7. Others could be taking the initial step towards a career in the field of design. The courses derived from this document will provide all students with a wide range of problem-solving experiences involving the materials and processes of technology and elements of design. While each of the subjects outlined in this document deals with content that is unique to itself, each also consists of basic conceptual content that is common to the subject grouping. For career planning purposes, students taking courses under any of these subjects should gain some insight into other technical subjects.

1.4 Sex Equity

Equal access for male and female students to all courses in the schools is a high priority of both the Ministry of Education and society in general. Promotion of this policy in technology programs requires a special effort, since there is still a psychological barrier to the acceptance of sexual equality in vocational areas that have traditionally been considered the domain of either men or women.

Co-operative effort on the part of parents, students, administrators, and teachers can help overcome such stereotyping. Course calendars, newsletters, and informative presentations are useful vehicles for

encouraging students to enrol in non-traditional fields. Enrolment can also be encouraged by inviting speakers who have experienced success in non-traditional educational fields and industrial occupations.

When planning courses of study, it is important that teachers be sensitive to the needs of both sexes.

1.5 Core Content

Separate sections are provided in each subject for planning basic, general, and/or advanced level courses. In design and technology a separate section is provided for planning these courses for Grades 7, 8 & 9. Each section includes aims and suggestions to assist teachers with course planning. Courses must include the skills and knowledge outlined as core content for each section. The core content is identified in chart form. All of the core content indicated for a particular level of difficulty must be included, either in one course or in the sequence of courses for the division.

Although in many cases the core content for the different grades and levels of difficulty is derived from the same units, the depth and breadth of treatment of this content material will vary according to the grade and level of the course. It is expected that the content will be developed

to a depth that is appropriate to each level of difficulty and that teaching strategies, projects, and evaluation methods will reflect both the level of difficulty and the grade for which the course is planned.

1.6 Course Objectives

All courses will be planned to achieve specific learning objectives which should be based on the aims for each particular course. The nature of the core aims is such that teachers can set learning objectives for each aim according to the grade and ability of the students. The depth and breadth of students' knowledge and skill competence, with respect to the core learning, will increase through successive courses.

Together, the aims, learning objectives, and core content constitute the core learning for a course. Any remaining course time can be structured to amplify the core learning and/or enrich the course with optional content. Additional topics that are appropriate to particular objectives and course themes may be selected from the section entitled "Part C - Content for Design & Technology Courses", at the end of this module, or from the course content listed at the end of any module in Technological Studies Guideline, Part B.

1.7 Integration of the Technologies into the Core Curriculum

The term "technology" is used to describe the ways in which theoretical scientific knowledge is put to practical use. With the rapid advances that are being made in technology, especially in the area of electronics, it is essential that all students receive an understanding of technology and the effect that it will have on their lives. All subjects are influenced by technology. Integrating the technologies into other subjects will therefore be of great value to all students.

Design & Technology teachers should work closely with other subject teachers to ensure that technological concepts and ideas are integrated into the core curriculum. This can be achieved by assisting these teachers in developing courses of study, and in assisting in the teaching of portions of the program.

2. PROGRAM AND COURSE PLANNING

2.1 Program Planning

Courses that are developed from this guideline will be student-centred, activity based, problem-solving courses. The teacher will act as a prime resource for individuals or small groups as students complete assigned tasks. The theory that is required to perform a task will be learned by the student as the task is being performed. Students will be encouraged to follow projects through all stages from initial concept through to design and production.

Using this approach to learning, students with different learning styles, at different levels of difficulty or at different grade levels could work together in the same class. If this occurs, teachers must ensure that tasks and assignments meet the needs of the individual students.

2.2 Course Content

Any course based on this document must be awarded a minimum of the equivalent of one-half credit. Where a course is awarded more than one credit, additional content will have to be included to supplement the core learning. This additional content must support the objectives planned for the course and may be selected from the units listed in the

section entitled "Part C - Content for Design & Technology Courses" or from the content listed for other subject groupings in the Technological Studies Guideline. For example, content from Technological Studies, Part B 3. Electrical Grouping may be incorporated into the design studies program if an electronic device is the possible solution to a design problem.

Where schools offer courses in more than one subject of this grouping, courses will be structured to avoid significant overlaps in course content. Courses in Design and Technology and Design Studies may mutually reinforce concepts that are basic to both courses, but the relative emphasis placed on these concepts and the nature of the activities that students experience in each course should reflect the aims and applications associated with the particular subject. The student who successfully completes courses in the two subjects should have an increased awareness of the types of occupational activities, working materials, tools and processes associated with each subject, as well as a feeling for the relationships between the subjects.

2.3 Safety

Safety is an integral part of all activities related to Design & Technology courses. The safety implications of

projects should be identified before the projects are undertaken. Students should work only with materials and machinery that are appropriate to their grade and level, and the teacher should decide which of these are within the students' capability. Students should also be supervised very carefully, and equipment and related guards should be checked frequently to assure that safe conditions are maintained. Safe practices should be promoted not only through initial demonstrations but also through the continuing reinforcement of such practices whenever materials, equipment, and hand tools are used.

The safety program can include content related to three areas: personal safety; the safe use of tools, equipment, and machinery; and the establishment of a safe environment in the shop and at home. Personal safety includes the use of appropriate clothing, the use of protective equipment, and personal hygiene. The safe use of tools and equipment involves the correct use of normal machine safety devices. A safe environment requires not only orderly responsible work habits and clean up procedures, but also the appropriate procedures related to fire prevention and containment, the handling and storage of materials, and the use of combustible fluids, glues, and chemicals, as well as the recognition and prevention of potential safety hazards.

In planning the safety component of Design & Technology courses, teachers shall:

- be familiar with the Workers Health and Safety Act and Workplace Hazardous Materials Information System (WHMIS) regulations;
- complete and retain a record of every accident that requires local or hospital treatment;
- ensure that students are informed of the procedures that must be followed in case of an accident;
- investigate the Industrial Accident Prevention Association (IAPA) school safety program;
- develop concise sets of conditions for the safe operation of particular machines (e.g., a checklist of conditions necessary before turning on a machine lathe) and ensure that students understand why such conditions are necessary;
- ensure that students understand why and when a hazard exists and that they are not simply following a rule because it appears to be a safe procedure;
- develop a student-licensing system for the use of tools, equipment, and special procedures;
- make students aware of the location, appropriate use, and method of operation of fire extinguishers in the shop area;
- use the systematic means of identifying and labelling dangerous substances and materials as specified in WHMIS, and inform students of this identification system.

Teachers also may:

- display safety posters;
- let students perform the duties of a safety inspector or supervisor;
- use videos, newspaper articles, and guest speakers to feature aspects of safety related to the shop;
- relate the wearing of protective equipment to aspects of life with which the student is familiar (e.g., recreation activities, sports figures, work situations);
- promote vehicle maintenance and safety;
- discuss safety associated with the home.

Most students receive their first formal introduction to industrial safety in the shop. The transfer of this learning to other experiences in their lives could be of immense value to them.

For safety program to be effective, the classroom teacher must act as a role model by adhering to all those safe practices that he/she is trying to impart to the students.

2.4 Evaluation

Courses in this module are to a large extent based on a balance in the acquisition of problem solving and technical competency skills. As students acquire these skills, they

are motivated to acquire related knowledge and develop desirable attitudes and understanding. The skills are reflected in the performance objectives set by the teacher when planning the course. It is against these performance objectives (which set the expected standards of achievement for the particular grade and level of difficulty of the course) that student achievement is measured.

Evaluation of student achievement involves assessment of both the process and the product of the skill. Checklists may be used by the student for an inventory of new learning or for process and time management analysis. Significant aspects of the completed operation are identified and commonly assessed with rating scales. As the checklists and rating scales are available to students, they can use them for self-evaluation as they strive for acceptable standards of competence. The assessment of design briefs and portfolios, technical reports, experimental results, and home assignments can also be structured around these techniques.

Comparison of the teacher's evaluation of a skill and the student's self-evaluation can often clarify the standards that are expected. Performance tests are a valid and effective method for assessing the achievement of a skill.

The success students have in understanding and applying theoretical knowledge in courses can be demonstrated and subsequently assessed through their planning and implementation of projects, work assignments and problem solving activities. A variety of assessment techniques, including short oral tests, objective tests (e.g., true-false and multiple-choice), short-answer completion, and regular question-and-answer tests, should be applied as additional evaluation processes. Test materials should be written at a reading level that is appropriate to student ability. The vocabulary used in the test questions should reflect that used in the classroom. Although students should be encouraged to write answers in proper sentence form, questions and answers that involve properly labelled diagrams are effective assessment instruments. Individual verbal tests may also be used.

The development of desirable attitudes and interpersonal skills are key components to a student's success. The assessment of these skills should be made through teacher observation.

2.5 Computers

Computers and the appropriate software that are available to schools increase opportunities for students to successfully accomplish independent study activities. The confidence

gained through these experiences is particularly important to young people, who can expect to face a working life characterized by changing technology and the constant need to update their skill and knowledge.

The effective use of computer programs as learning tools in the classroom will require adjustments in teaching strategies. Students continue to need hands-on experiences with the materials, tools, and equipment associated with courses in this guideline. Computer programs applied at appropriate times can help the teacher to teach, reinforce, review, and test the associated learning. Through the use of equipment for simulating programmed processes, Design & Technology shops may provide students with experiences in Computer Assisted Drafting (CAD) and Computer Assisted Manufacturing (CAM) paralleling those of larger more complex systems used in industry.

2.6 Language and Learning

Since the language activities of reading, writing, speaking, and listening are the basic means of learning common to all subject areas, all teachers must co-operate in ensuring that the four aspects of language receive appropriate emphasis and treatment in their subject areas. A deliberate attempt should be made to foster the student's use of the specialized language and terminology of a particular

discipline.

Design & Technology courses provide many opportunities for teachers to assist students in language activities; for example, by encouraging the correct use of technical terminology; by assigning written and oral technical reports; by evaluating language in written assignments, tests, and examinations; by conducting group discussions on technical topics; and by emphasizing effective communication skills during question-and-answer periods. Students will also better appreciate teachers' efforts to promote language skills if they understand the relationship of these skills to the expectations of business and industry.

2.7 <u>Life Skills</u>

In addition to providing problem solving and technical skills, Design & Technology courses provide a variety of life skills that will be of use in both personal and private life. Students should also be encouraged to develop the ability to work co-operatively with others in a productive work setting, to deal positively with authority, to acquire safe and neat work habits, to recognize the importance of punctuality and attendance, and, through taking on group leadership roles, to accept responsibility.

It is vitally important that all students be given opportunities to acquire basic life skills. Educators involved in design courses should recognize the contribution they can make to this area of student learning.

2.8 Information on Career Opportunities

All students must be made aware of the career opportunities available through Design & Technology. As well, Design & Technology students should have access to current information on the educational requirements for apprenticeship and other career programs and on employment opportunities. Career planning can be facilitated by providing students with access to the Job Search Skills Program, with information on School-Workplace Apprenticeship and Linkage programs, and with information on projected employment trends. For these reasons, guidance counsellors and Design & Technology teachers should work together to:

- provide students with the information they need to make appropriate educational decisions;
- assist students in their subject selections;
- advise students on the most appropriate training routes for meeting their needs;
- reinforce students job-search and interview skills.

2.9 Co-operative Education

Co-operative education can provide experiences that not only enhance acquired skills but also provide students with realistic expectations of the day-to-day practices and requirements of business and industry. The parameters within which co-operative education can take place are set out in Ontario Schools, Intermediate and Senior Divisions (OSIS) and Policy and Procedures for Co-operative Education in Ontario Secondary Schools: 1989, and include student experience and time in the workplace.

Boards and schools should take advantage of this opportunity to provide a more realistic link between school and work. Co-operative education can provide all students with valuable experiences in career exploration and skill development. In some cases the out-of-school component may provide the necessary hands-on experience with equipment not readily available in the school.

Subject teachers must be directly involved in co-operative education programs to ensure a relationship between the in- and out-of-school components. In addition to their in-school instruction, teachers should actively monitor students in out-of-school situations as part of their regular assigned duties. In this way teachers, too, can foster and maintain the necessary links with the world of

work. Students should have opportunities to reflect on how their workplace experiences are linked to their in-school component.

In all cases, the in-school and out-of-school components of a co-operative education course must maintain the integrity of the course's stated educational objectives. Both school officials and employers have a responsibility to monitor the out-of-school component to ensure that the total course objectives are being met. The establishment and maintenance of meaningful evaluation procedures are to be a co-operative effort involving the classroom teacher, the supervisor in the work setting, and the teacher-monitor.

2.10 Work Experience

Whereas in a co-operative education course the time for the out-of-school component must be built into a student's timetable, work experience is an integrated part of a specific course. As a component of the student's course, work experience gives the student opportunities to exercise and reinforce the technical skills and knowledge acquired in school. It also provides an orientation to the workplace and opportunities for additional career exploration through discussions with experienced workers. It has been found that work experience is most beneficial to students in their third or fourth year of secondary school.

All work experiences should reflect good planning and should normally be limited to one or two weeks in any one school year. Exceptions may be made for basic-level programs, but in such cases the time of the work site should never exceed a total of four weeks in any one school year. The student does not normally receive pay when participating in work experience.

The activities and objectives of the learning experiences for the student must be discussed beforehand by the teacher and the employer or supervisor. Both the employer and the student are required to prepare evaluation reports on the student's experience.

Every precaution must be taken to ensure the safety and protection of students while they are on a job site. Planning for a work experience should, therefore, incorporate provisions for safe work stations, special instruction on safe practices and proper clothing, and the coverage required through the Workers' Compensation Board.

2.11 Exceptional Pupils

Exceptionalities are categorized in the Education Act, as behavioural, communicational, physical, intellectual, and multiple, with identification of exceptionalities to be made

by a school board's identification, placement, and review committee (IPRC). Curriculum modifications for exceptional pupils must accommodate their individual needs. Some modifications may be relatively simple; others may be extensive and require the use of specially designed equipment. Additional assistance may be required for severely handicapped students.

When recommending exceptional pupils for placement in a Design & Technology course, the IPRC, in consultation with appropriate personnel, should consider the following questions:

- Is enrolment in the course in the student's best interest?
- Are there adequate safety precautions?
- Are the facility and equipment appropriate for the nature of the exceptionality?
- Can provision be made for adequate supervision?
- Is the teacher adequately trained and prepared to make appropriate program modifications?

An exceptional pupil's program must be based on and modified by continuous assessment and evaluation. Evaluation techniques, such as observation and teacher-student interviews, should supplement the more formal types of assessment, so that a more personal and complete picture of the student's progress may be obtained.

PART B - DESIGN & TECHNOLOGY COURSES

Design and Technology

Courses in this subject provide opportunities for students to discover and use their creative abilities in projects that involve tools, machines and materials. Students enrolled in the Design and Technology program enjoy directed experiences that enable them to design and build projects that meet specific needs. The application of problem-solving and design procedures to meaningful projects stimulates students' analytical talents, creativity, and inventiveness. In this way, students acquire basic knowledge and skills in the manipulation of tools, machines and materials and become aware of the various fields of technology, current industrial practices, and potential career opportunities.

Elementary Program	-->	D&T Gr.7,8 & 9	-->	B D&T2G A	-->	B D&T3G A	-->	B D&T4G A
				up to 2 credits per year		up to 3 credits per year		

1. Grades 7, 8 & 9

Many students beginning a formal Design and Technology program in Grade 7 will have had some introduction to tools and materials either through their experiences outside of the school or as part of their work at interest centres in

the science and art programs or other technology related activities in earlier years. In earlier grades some students may also have been introduced to the Design and Technology shop and given opportunities to design and make three-dimensional projects and to apply simple scientific and technological concepts. These experiences, which help students to develop some familiarity with and confidence in technology at an early stage in their development, should be supported wherever possible by Design and Technology staff and administration.

This section deals with courses for Grades 7, 8 and 9, and contains aims and suggestions for developing courses. The core content is identified on pages 89-99 of this document. The depth and breadth of treatment of each unit of content identified as "core" depends on both the grade and the length of the course being offered. If only the minimum time is available, then some of the core content will necessarily be given superficial treatment. It is suggested that fuller treatment be given to those core items related to <u>safety; design; fabrication - materials and processes; careers; engineering, power, and control technology (mechanical and/or electronic kits)</u>.

The core learning in each of Grades 7 and 8, is designed for a minimum of 60 hours of classroom time, while the Grade 9 core is built on a minimum of 110 hours of classroom time.

This allows for optional material to be included so that courses can be designed to meet a local need.

Aims

All courses in Grades 7, 8 & 9 will provide students with opportunities to develop:

- a sense of pride in the application of good work habits to a job or project, a capability for critically evaluating the results of their own work, and a sense of satisfaction in the completion of a job that is well done;
- an intellectual curiosity related to fields of design and technology and the imagination needed for continued learning, decision making, and problem solving;
- the ability to use safely and confidently a variety of hand and power tools, equipment, and materials in a practical work setting;
- an awareness of a wide range of processes used in industry through experiences in the school shop;
- an awareness and appreciation of the need for the conservation of energy and materials;
- the ability to co-operate when working with others;
- initiative in completing assigned tasks;
- an awareness of their personal aptitudes and interests related to fields and careers in technology;

- the ability to plan and perform tasks efficiently using a logical sequence of operations;
- some capabilities for creative thinking related to the process of designing;
- awareness of career and occupations related to technology.

<u>Suggestions for Teachers</u>

The core content for these years is intended to provide students not only with introductory skills and knowledge related to this technology but also with successful experiences in design and constructive activities. Safe work habits, a positive attitude towards good work, and confidence in using technology should be objectives of every Design and Technology program. To achieve this, these courses are project-oriented; the projects are planned around objectives that reflect both the core learning (i.e., aims and core content) and the stage of the students' development.

The Design and Technology program in Grades 7, 8 & 9 should be organized around three major areas: (a) problem solving, designing, and planning; (b) fabrication and production processes; and (c) engineering, power, and control technologies. In this way a unifying framework is provided for the various student activities involved. Consideration

should also be given to fostering in students a concern for safety, providing for the needs of exceptional students, evaluating student achievement, and providing students with information on career opportunities.

Design. Design links research, problem solving, planning, and project solution. Problem-solving skills may be developed using real and everyday problems. For example, students are easily motivated by problems that they or their friends may encounter in real life. In developing a problem statement, students should be able to identify and attain a solution within a reasonable period of time. The process should involve them in a personal investigation of potential solutions. In this way students should develop both inquiry and reporting skills.

Initially, students should be involved with designing at a level they can achieve conceptually and technologically. Success in solving the initial problems and in producing simple, useful products is very important to the novice Design and Technology student. For this reason such activities should be completed early in the Grade 7 course. When projects are well designed and constructed, the young learner's satisfaction and confidence increases. While teachers should limit the scope of design problems at the outset, controlling the number of possible alternatives within the time available, they should recognize the need

for student involvement in the selection of the final design. Partial designing focuses student input, while redesigning (e.g., of a poorly designed model or product) may stimulate a broader input. In all cases the design investigation should encourage consumer and product awareness. As well, a discussion of the creativity of designers, inventors, and their products could add to students' understanding of the role of the designer. A thematic approach focusing on design themes such as Canadian designers and inventors, achievements of the aerospace industry, and international design projects may interest some students.

The planning phase may include the project sketch, the bill of materials and the identification of the fabrication steps and processes necessary for construction. Free-hand sketching of the project may be supplemented with an introduction to orthographic and pictorial projection. Simple dimensioning may also be included. Students may further develop the project design three-dimensionally by making a mock-up, prototype or model. These provide ideal ways to communicate a problem solution and encourage creativity and inventiveness. From a model it is very easy to visualize the bill of materials, the design, the fabrication steps, and the processing techniques required. Materials such as scraps of wood, plastic, and cardboard can be easily developed into a mock-up of the intended project.

The core content on problem solving, designing, and planning can help students to develop their communication skills. The abilities that students develop in designing, inventing, creating, and presenting novel solutions to problems should give them the confidence to tackle many of the problems that they will continue to encounter in our dynamic technological society.

<u>Fabrication - materials and processes</u>. The core content outlined on pages 91-94 provides for the selection of materials and the application of processes in the fabrication of a product. When students are first introduced to the Design and Technology program, they are more intrigued with the processes of making things. This initial enthusiasm can be used as an introduction to a more theoretical study of design, materials and processes. Initially a hands on approach should be encouraged.

Projects that require a variety of materials and involve a range of processes contribute to the integrative aspects of the learning in design and technology. The materials provided should include wood (processed and natural), plastics (resin, pellet, sheet, and bar stock), and metals (sheet and bar stock). Materials such as leather, natural and synthetic fibres, and minerals (ceramics and concrete) may also be provided as resources. As students work with

the different materials, they should not only develop an awareness of the origin, qualities, and general uses of each, but practice conservation of resources, and environmental responsibilities.

Engineering, Power and Control Technology. This core-content area should provide students with an opportunity to build structures, and work with electromechanical devices and sources of energy. It is important that students use safety precautions for these applications, not only for activities that take place in the school shop but also for possible activities outside of the school. The section on safety (page 17 of this module and page 18 of Technological Studies, Part A: Policy for Program Planning) provides suggestions that are useful in this regard.

Electronics, microcomputers, robotics, hydraulics, and pneumatics offer many potential enrichment challenges that may be explored by gifted students who are interested in this content area. Topics related to technology in the home may also be included where appropriate. Students may acquire basic skills related to simple electromechanical services in the home. These should be treated as problem-solving challenges and should be limited to those that can be solved safely and efficiently.

Planning for exceptional students. The Design and Technology program planned for students with special needs must provide for the exceptionalities and abilities of these students. As these students often require short periods of individual instruction, it is important to plan their learning activities while other students are creatively occupied. Students within this group require simple life skills, that may be broken down by sequencing and task analysis. In this setting, technology may be viewed simply as a "tool box" and design as a "process of choices". Support teachers should also be encouraged to provide support, along with the shop instructor, during the class sessions in the shop.

Gifted students may be highly receptive to independent study of a theoretical nature in Design and Technology. They should be stimulated and challenged by innovative design problems that will develop their creative and inventive abilities. They may require less time to master the necessary basic skills related to problem-solving and fabrication processes. Additional suggestions for instructional strategies and other considerations for dealing with exceptional students, including the intellectually gifted, are provided on page 2[illegible] of this document.

Evaluation of student achievement. The evaluation process is an important aspect of all student projects. Joint assessment by both the student and the instructor can be most effective. This involves an overall examination of the various aspects of a project from the development of the project solution to the completion of the product. The final score should represent a co-operative assessment, which could be an average or a negotiated compromise of the two assessments. Additional comments about the evaluation of student achievement are outlined on page 20 of this module.

Career planning. Design and Technology offers a range of experiences involving the creative use of the hands and mind and provides students in Grades 7, 8 & 9 with unique opportunities to test their aptitudes and interests for different vocations. Information related to possible occupations and further training options associated with the different technological fields can be effectively presented to students during informal discussions. For this reason it is useful for teachers to be familiar with the programs in both Grades 7 to 9 and Grades 10 to 12, as well as postsecondary programs.

2. Grades 10 to 12

Courses in Grades 10 to 12 build on the skills and knowledge acquired in Grades 7 to 9. Together, the Design and Technology courses in the two divisions form a program that has common aims and a natural learning sequence. In comparison with students in Grades 7 to 9, those in Grades 10 to 12 undertake more complex problems, develop more sophisticated solutions, and become more self-reliant in the process. It is expected that all students enrolled in Grades 10 to 12 will have acquired competence in the core learning specified for Design and Technology courses in Grades 7 to 9.

The focus of Design and Technology courses in Grades 10 to 12 is on the development and construction of projects that are designed to meet specific needs. The nature of project solutions will reflect the types of needs or problems to be solved. For example, projects can include objects to take home, products made to sell, improvements to existing products, repairs, audio-visual aids, experiments, presentations, design folios or reports.

Students should be encouraged to communicate information associated with their projects in a variety of ways. Experimentation, literature-search, notetaking, and presentation and demonstration techniques can be used by

students to explain particular processes or machine operations to other students. As well, the preparation of a design folio on a particular project might serve several purposes. It could include a record of the time spent, of developments and decisions on various aspects of the job, and of product evaluation. As well, if students initially prepared the estimates necessary for tenders to contract the jobs, their reports could serve as a basis for analysing their success in a simulated contracting venture.

Career exploration can be an aspect of many activities that make up Design and Technology course work. Students should be aware of the career information that may be obtained through the Job Search Skills Program, and course calendars from colleges and universities. They may also investigate local occupations related to Design and Technology and report on them as an additional source of career information.

Safety is an important part of all Design and Technology courses. The nature of Design and Technology requires that correct safety practices be established when students commence their studies and continue throughout the course. It is the responsibility of the teacher to ensure that all students are aware of hazards in shops and that established procedures are followed. Special safety requirements relating to specific operations, machines, and situations

should be identifies as these problems arise. When group projects are undertaken, safety films, posters, and other resources, available through groups such as the Industrial Accident Prevention Association (IAPA) and the Construction Safety Association, may be used to increase student awareness of safety. In general, students should be provided with opportunities to develop:

- the ability to use all equipment, including hand tools and portable electric equipment and accessories, correctly and safely;
- an awareness of the potential safety hazards in the home and industry;
- the ability to lift and carry objects related to common domestic and industrial applications safely;
- an understanding of elementary first-aid and fire-safety procedures;
- a knowledge of the mechanics of Workers' Compensation for industrial employees;
- through the Workplace Hazardous Materials Information System (WHMIS), an understanding of the need for the safe storage and use of combustible fluids, glues, chemicals, and their containers;
- an awareness of provisions for environmental safety in the community.

Additional safety considerations are outlined for course planners on page 17 of this guideline and on page 18 of Technological Studies, Part A: Policy for Program Planning.

Considerations relative to evaluation of student achievement in Grades 10 to 12 Design and Technology Courses are outlined for course planners on page 20 of this guideline.

Courses in Design and Technology are authorized for Grades 10, 11 and 12 at the basic, general, and advanced levels of difficulty. The core aims and suggestions for designing courses at these levels are provided in the subsections that follow. The core content is identified on page 89 of this document. The time allotted to Grades 10 to 12 courses may vary and credit may be offered for up to 2 credits in Grade 10 and up to 3 credits of in-school work in each of Grades 11 and 12. If only the minimum time is available, then some of the core content will necessarily be given superficial treatment. It is suggested that fuller treatment be given to those core items related to safety; design; fabrication - materials and processes; careers; engineering, power, and control technology. The Grade 11 course is a prerequisite for the Grade 12 course.

Design and Technology - Basic Level

(Grades 10, 11 and 12)

Aims

All courses at the basic level will provide students with opportunities to develop:

- safe work habits and a positive attitude towards the safe and correct use of tools, equipment, materials, and protective clothing;
- competence in the communication skills required to understand and record ideas, plans, and information;
- an appreciation of good design and high-quality work;
- pride in the quality of their work and the ability to work co-operatively with others;
- problem-solving skills related to applications of technology and the self-confidence they require to apply them to home maintenance and other personal uses;
- insights into industrial applications of technology and related career opportunities.

Suggestions for Teachers

Project work. In the project work associated with Design and Technology courses in Grades 7 to 9, students will have acquired some knowledge of materials, the basic skills required for processing those materials, and some awareness

of the planning and design processes involved in producing a product. Grades 10 to 12 courses build on these skills and knowledge. Projects in Grades 10 to 12 should account for at least 70 per cent of the course time.

Four major phases of the design process can be distinguished from the numerous stages employed in all Design and Technology projects. These are initiation, synthesis, implementation, and evaluation. Specific projects and exercises may emphasize one or more of the phases or stages in greater depth. Each phase of the process should be experienced by every student. The sophistication of the activities undertaken in each phase can vary with the level of understanding of the student, but should increase progressively with each new project.

The initiation phase includes the selection of the project and the organization of the people and resources required to carry out the task. Initially, a teacher-initiated planning sequence, which includes selected input from students, may be appropriate. In some cases, it may be necessary to provide a prescribed project idea that is suited to a specific need or interest of the student. Projects that are made from a variety of materials and that involve several processes are recommended since they integrate various aspects of production.

In the synthesis phase, the project is defined in specific terms and the requirements, resources and restrictions may be identified. Possible solutions are suggested, and these are analyzed and evaluated until one solution is selected to be developed and ultimately constructed.

The following suggestions may be considered in planning and initiation and synthesis phases:

- Projects may be completed by the individual or by small groups, using their own ideas, prototypes developed by the teacher, cutouts, mock-ups, or models.
- Sources of suitable projects may be found within the home, the school system, or the community at large.
- When students are applying basic design principles to the development of their projects, their general problem-solving ability is also being fostered.
- Projects may take the form either of a full-size model (involving the application of the principles of ergonomics) or a scale model (involving the use of precision instruments).
- Geometric construction may be taught when it is appropriate to particular projects.
- Students should become proficient in developing freehand sketches of their planned projects in pictorial and orthographic style.

- Some projects should include cost analysis and production alternatives.
- Orientation sessions should clarify for students the various phases and stages in the design process, and provide information on procedures related to the project and the scope of the available resources (human and technological) within the school and the community.

The implementation phase includes the fabrication of the product associated with the project. It begins with a set of sketches and drawings and ends with the completed product. In the evaluation phase, the student tests and modifies the product and assesses whether it satisfies the identified needs.

Fabrication - materials and processes. Project activities must be planned to assure that each student accomplishes the core learning that has been identified for the fabrication processes related to wood, metals, and plastics. Specific exercises on skill development may be planned to provide students with introductory experiences in carrying out operations and working with materials that may be involved in the implementation of their projects. To challenge students of different abilities, the degree of difficulty of these practical exercises and the number of exercises assigned may vary.

Some operations can be accomplished more accurately, rapidly, and effectively by machine; other operations can be accomplished with more refinement and delicacy by hand. During the course students should be provided with opportunities to make such choices and to select the most appropriate hand or power tool for each of the various tasks that they undertake.

The following are some additional suggestions related to the core learning associated with fabrication - materials and processes:

- Films, videos, tours, and research assignments can be used to explore materials and processes where equipment is not available. These approaches may also be used to examine methods of production and careers.
- Parents and other members of the community who have specialized knowledge or skills related to a particular core area are a good resource. Such individuals are often willing to participate in the program by giving talks or demonstrations and by providing examples of the materials used in manufacturing processes.
- One effective approach that involves students in a co-operative effort is the manufacture of a product using mass-production techniques. The design process leading to the prototype to be mass-produced may involve small groups of students working on different problems. The

mass-production process will involve a large group of students in the repetitive processes required to make the individual components, assemble them, and tests the final products. Where it can be arranged, a visit to a local manufacturing concern may contribute to student learning related to this type of activity.

Engineering, power and control technology. Students working at the basic level can be most effectively introduced to power and control technology through practical experiences. Simple mechanical transmissions, gears, levers, and wheel principles may be introduced through studies of the bicycle. The principle of fluid power may be introduced through an examination of hydraulic jacks and pneumatic drills. Students should be able to identify the various form of energy that they may encounter during their shop experiences. Films, tours and pamphlets may be used to provide students with some insights of how electrical energy is generated.

Projects and practical exercises related to simple electronic circuits and systems involving bells, buzzers, and relays can provide an effective introduction to the knowledge and skills students should acquire in electricity or electronics. The gathering, organizing, and interpreting of performance data from an existing circuit provides an excellent assignment.

Students can also build a simple system on a previously prepared circuitboard and do minor repair work. The reading of simple pictorial, schematic, and connection diagrams can be one aspect of the construction exercise. The appropriate use of hand tools, soldering, and test equipment are other aspects of the core learning that can be built into such projects.

Home technology. Activities related to home maintenance and repair can provide learning experiences that reinforce basic core skills and introduce new skills and knowledge. Optional content related to building construction may be selected from the list of course content associated with the construction subjects of the Technological Studies Guideline.

Design and Technology - General Level

(Grades 10, 11 and 12)

Aims

All courses at the general level will provide students with opportunities to develop:

- good work habits, a capability for critically evaluating the results of their own work, and a sense of satisfaction in doing a good job;
- good safety procedures;
- an attitude of respect for the achievement of others and a willingness to co-operate with fellow workers and supervisors;
- the ability to record and understand technological information, ideas, and plans;
- an appreciation of good design and excellent work;
- competence in the basic skills required for the care and use of hand and power tools;
- the clear and creative thinking necessary for successful problem solving and decision making related to applications of technology;
- the ability to plan and perform tasks efficiently, using a logical sequence of operations;
- insights into industrial applications of design and technology, related career opportunities, and the

implications of rapid technological change for occupations.

Suggestions for Teachers

Project work. The development and implementation of projects should account for at least 60 per cent of the course time at the general level of difficulty. These projects should build on the skills and knowledge that students acquired in earlier courses in Design and Technology.

Projects may be structured around four major phases: initiation, synthesis, implementation, and evaluation. All students should experience each phase of the process, and the activities involved in each phase should be increasingly challenging as students undertake projects of increasing sophistication and should be planned to assure that the core learning will be accomplished.

In the initiation phase the project is selected; students, individually or in groups, make a commitment to complete the project. Then the available requirements, resources, and restrictions for the project are identified. orientation sessions should be used to provide students with a review of the particular aspects of the four phases that may require reinforcement of further clarification. Any special

requirements for the design and accompanying folio should be clearly identified.

Problems suitable for project work can come from many sources: a student's particular interest, the home, the school, the community or some other source. Products, designed as particular solutions to a defined problem, may take the form of full-size models (requiring ergonomic considerations) or scale models (involving the use of precision instruments).

In the synthesis phase students should be provided with opportunities to practise the various stages in the design process - from defining the problem to completing the final design (i.e., the product solution). To provide these practice opportunities, the teacher can use various strategies, involving cutouts, models, mock-ups, and prototypes. Eventually, each student should be able to develop a final design to respond to a problem of his/her choice, generating several possible solutions within the given constraints and then selecting and further refining the "best" solution. The process used by students to investigate and solve design problems may be fostered in an orderly flow of ideas or more randomly (as in "brain storming"). In addition to preparing perspective drawings and plans of their final products, students should be able to interpret drawings and working diagrams from other

to interpret drawings and working diagrams from other sources.

When design problems are such that students must conduct an information search, all available resources should be used. These include textbooks, reference materials, libraries, periodicals, magazines, and community contacts in business, industry, or government.

The understanding of the principles of design can be enhanced through the analysis of well-designed products and the redesigning of other products to improve particular features. The content units listed on pages 100-107 for design studies may be a useful resource when planning these activities.

The implementation phase begins with a set of sketches and drawings and ends with a model or prototype. The core content related to the materials and processes of fabrication is an important part of this phase. The final phase - evaluation - includes the testing and possible modification of the product. It should assess whether the product has satisfied the need that was identified in the beginning.

<u>Fabrication - materials and processes</u>. The sequence of projects should be planned to provide recurring

plastics and other synthetic materials. They should acquire some feeling for the characteristics of these materials through processing activities and gain some insights into the range of their applications in manufacturing.

Specific exercises or mini practicals may be planned to provide students with introductory experiences in carrying out operations and working with materials that may be involved in the implementation of their projects.

Students should become aware of the fact that manufacturing often brings together a variety of materials, energy sources, and control elements and uses a wide range of related technological processes to produce a product. For example, a television set is a product in which wood, metal, plastics, and electronics are used in conjunction with electromagnetic radiation and electrical energy to form images. The basic processes experienced in the shop can often be related to the more sophisticated processes used in industry.

The following are some additional suggestions related to the core learning associated with fabrication - materials and processes:

- Course planning should provide opportunities for student to work independently and in small groups. Different

groups of students can work on different problems, which can involve the special knowledge and skills of individual students.

- When necessary, students may be taught how to design and construct special jigs or holding devices, to increase safety, accuracy and proficiency.

Large student groups may be involved in mass-production techniques to manufacture a product. In such cases the design stage should include mass-production requirements, restrictions, and control processes. The design process may involve small groups of students working on specific problems related to the whole. The analysis of the design selected for mass production should lead to clear sequences of separate fabrication activities that can be performed repetitively. The end result of this sequence of activities should be the final assembly, testing and evaluations of the products. The necessary planning and organizational considerations involved in the mass-production process can be used to nurture student skills in leadership and group dynamics. To accomplish the overall process successfully, students must learn to function effectively as a group and to assume individual commitments that serve the goals of the group. Visits to a local manufacturing concern can also contribute to the learning of students involved in mass-production activity.

<u>Engineering, Power and control technology</u>. At the general level power and control technology should be examined through a variety of applications. Students should examine mechanical devices, such as clutches, drive shafts, belts, universals, and gear trains, to identify basic machine principles and to increase their understanding of how mechanical power is transmitted. Similarly, pumps, valves, and cylinders may be examined in relation to the control and transmission of fluid power in simple hydraulic and pneumatic systems. Students may undertake individual research topics in order to explore topics related to heat energy, such as the use of turbines, electrical-energy generation, the use of solar devices, and the conservation of energy in the community.

Students at the general level can be expected to develop their knowledge and skills in electricity or electronics in a variety of ways. They can use test instruments to study circuits that include magnetic-field components such as solenoids, relays, motors, generators, and transformers. They can design and build electronic circuits such as light- or sound-controlled alarm circuits. They can repair electrical or electronic appliances and become familiar with the use of simple circuit boards, schematic and connection diagrams, component-specification sheets and other communication devices that can assist in problem-solving tasks related to repair. Students should be able to build a

simple low-voltage power-supply system and adapt it to suit a need. They should also be able to design, assemble, and test at least one circuit involving the power supply and a load. Reference materials, films, components, kits, and other resources can all contribute to student learning in the electrical or electronic area.

Home technology. The core learning related to home maintenance and repair should provide students with the skill and knowledge they require to undertake some specific tasks. This learning should also instil in students the confidence they require to research and undertake other home-maintenance problems.

Optional content related to building construction may be drawn from list of course content for construction subjects in the Technological Studies Guideline. A model of a house may be built as a group project. Each group could be responsible for the organization and planning of one or more stages in the project.

Design and Technology - Advanced Level

(Grades 10, 11 and 12)

Aims

All courses at the advanced level will provide students with opportunities to develop:

- a positive attitude towards safety in the work environment and safe work habits in the proper use of tools, equipment, materials, an protective clothing;
- respect for the achievements of others and a willingness to co-operate with fellow workers and supervisors in achieving a common goal;
- the ability to express and interpret technological ideas, plans, and information through sketches, instrument drawings, and reports;
- an appreciation of quality design and the inherent work involved;
- problem-solving skills related to applications of technology;
- the ability to plan and perform tasks efficiently using a logical sequence of operations;
- the self-confidence they require to undertake simple home-maintenance and repair tasks and insights into particular applications of technology through research on available literature and other resources;

- insights into industrial applications of technology, related career opportunities, and the implications of rapid technological change on occupations.

Suggestions for Teachers

Project work. The exploration of theoretical concepts and knowledge that provide the necessary background for the development of projects should take at least 50 per cent of the course time. The remaining time should be devoted to acquiring and applying hands-on skills related to the processing of materials and the fabrication and testing of projects.

The overall emphasis of the project activity will be on practical problem solving and the application of design principles to the product solution. The problems to be solved should reflect students' interests or needs. Projects may culminate in either full-size or scale-model products and may involve students working individually or in groups. Projects should be planned so that the core content is adequately covered.

Project work should be structured around four major phases: initiation, synthesis, implementation, and evaluation. The initiation phase involves the selection of the projet, identification of the team members if it is a group project,

and orientation sessions that clarify the available resources, identify particular skills and knowledge that could be useful, and outline clearly the expectations for evaluation purposes (e.g., a report or a presentation).

The synthesis phase involves problem-solving, the application of the principles of design to determine the "best" solution, and the production of instrument drawings that can communicate the proposed product solution to others and serve as a basis for preparing the cost analysis prior to implementation. Students can analyse existing prototypes and commercial products to identify good features and recommend improvements to other features in order to further develop their problem-solving and designing skills. This approach should also lead to some discussion of design-problem solutions as they would be applied in factory production.

Synthesis may involve exercises that are planned to provide students with the necessary skills and knowledge that they may require in carrying out operations and working with materials as they implement their projects. These exercises lead to the production of a demonstration workpiece.

Drafting skills may be enhanced through the use of CAD in projects related to electrical, architectural or mechanical fields. The following are four possible approaches that

reflect different interests of students in the architectural field:

- The "nuts and bolts" approach. Students read blueprints and copy drawings of various types.
- The consultative service approach. Students meet a prospective client, interview the client to get ideas, and then provide the client with possible solutions to his/her design problem. This could involve a new kitchen, bathroom, patio, or spa.
- The "dream-house" approach. Each student completes a set of drawings of a dream house, including floor plans, elevations, plumbing, and electrical layouts.
- The scientific approach. Students study the energy implications in present-day construction. Such a unit could involve experimentation with building material, research, presentations, and report writing, in addition to drawing.

In working with the full range of materials and processes specified in the core learning, students in advanced-level courses should have opportunities to make decisions in the synthesis phase related to the stress that the final product is expected to bear and the physical capability of the materials being considered to sustain that stress. In some cases simple apparatus may be designed to compare these materials under appropriate tension, compression, shear, or other force as required. Such apparatus could also be used

to test joints that students have made as mini-practicals. Hardness and other metal properties that may be altered by treatment in the shop may also be investigated. Where laboratory investigations of materials are undertaken, the possible industrial applications and processing methods for the materials could also be examined.

As an optional activity, some students may wish to research and prepare papers on individual designers, their products, and their role in business and industry. The patent process may also be of interest to some students.

The implementation phase involves extensive hands-on activity associated with the processing and fabricating of materials and results in a completed product. In all activities associated with the implementation phase, safety considerations are important.

The evaluation stage provides an opportunity for the student to critically examine the final product. This may include earlier testing of a prototype or the testing of the final product and making recommendations for improving the product to better satisfy the identified need.

<u>Fabrication - materials and processes</u>. The core related to fabrication - materials and processes should not be perceived in isolation from the content listed for

engineering and control technology. Since the modern products of our manufacturing industries combine materials, energy sources, and control devices, the problem-solving and design activities associated with the development of student projects will tend to contain similar mixes.

The ability of students in advanced-level courses to undertake independent study and the diversity of their interests should be nurtured through the use of optional content. The use of out-of-school resources, including specialists in the community and available resources in other institutions, can also be used effectively to expand the technological opportunities available to students.

The suggestions related to activities with wood, metals, and plastics outlined in the previous section for general-level courses may be adapted for advanced-level courses. Such adaptations could involve students in the design of jigs and fixtures for off-centre work, fluting, and centring in wood-turning, as well as in the design and manufacture of moulds for fibreglassing.

Students should participate in at least one group or mass-production project. See the suggestions related to this type of activity in the suggestions for teachers for general-level courses.

<u>Engineering, Power, and Control Technology</u>. Investigations of power and control technology at the advanced level should initially examine some typical ways in which energy and power are converted to alternate forms (e.g., mechanical to electrical, electrical to fluid, and fluid to mechanical). Such conversions can be discussed using devices (electrical, hydraulic, and pneumatic), components, schematic diagrams, pictorials, and other resources. The use of such conversions in robotic devices can be taught through audio-visual materials, kits (including computer interfaces), or visits to local industries. Students may also undertake individual research topics to explore further such topics as the use of nuclear energy to generate electricity, energy conservation in the home and industry, and alternate energy sources.

Investigations of control technology in courses at this level focus on applications related to electricity and electronics. Students should become familiar with the current applications of electronic technology associated with themes such as audio systems, interface systems, and robotics. In the case of audio systems, students could examine input and output devices (e.g., microphones, tape recorders, speakers, and earphones) and identify the various stages in the electronic control of signals between input and outputs. The operation of a local ham-radio station would also support such a theme.

Each student should be involved in the construction of an electronic circuit or a device that will produce or modify sound, light, or motion. This activity should permit students to pursue a topic of interest, require them to use electronic test equipment and other measuring devices where appropriated, and provide opportunities for the development of problem-solving skills related to the troubleshooting of a faulty circuit or device. The availability of components that demonstrate up-to-date technology, project books, trade journals, electronics magazines, circuit boards, kits catalogues, schematic circuit diagrams, and data sheets for motors, generators, and micro-electronic chips (logic and other digital circuits) can motivate students in their work with these circuit-construction activities.

Students can investigate the use of microcomputers in the control of simple processes. Where feasible, opportunities for discussions with specialist in local industry and in other educational institutions would assist students who are interested in this area. The application of microprocessors in the home for the control of home heating, telephones, alarm systems, and particular appliances can also provide opportunities for further investigation where such equipment is available to students.

At the advanced level students should be encouraged to explore the new technologies in house construction, security and home management.

Design Studies

Courses offered in design studies provide opportunities for students to solve both identified and open-ended problems. The solution to these problems lead to products or systems that fill particular needs of society and that have value in the marketplace.

Students will have numerous opportunities to participate in the design process through a variety of approaches and techniques. They will also have the opportunity to compare commercial products designed for similar purposes, to identify key design features, and to acquire some ability to discriminate between good and poor design.

The identification of appropriate design problems is an important aspect of courses in design studies. Ideally these should be perceived by students as real problems whose solutions serve social or technological needs in the community. A social problem may focus on a compassionate service for an individual or on a community project identified by a local service group. A technical problem, possibly identified by an individual in a local business enterprise, may be related to conservation and energy or may involve an improvement to quality of life. Students will be able to identify literally hundreds of problems during their routine activities in the school and the community once they develop a sensitivity to recognizing them.

Courses in design studies will also introduce students to the role of designers in society and to the various educational and training paths that can lead to a career as a designer. The emphasis in most courses will tend to focus on industrial design and to deal with problems related to the quality of the human environment. However, engineering design, graphic design, interior design, theatre design, fashion design, or craft design might also form an acceptable focus for some courses.

Design concepts can be offered in separate and distinct courses in design studies or they can be introduced into any of the technological studies subjects. In either case, the use of the design process can help to create interesting themes that will often inspire students to delve deeper into particular subject content. Presenting students with the opportunity to modify an existing design to solve a problem is an excellent way to introduce the basic principles of design. However, the teaching of design may also focus on the overall design of a new product.

There are two basic approaches to teaching design. The first involves individuals or pairs of students working independently. The second involves students working in small or large groups in which each student contributes to the planning and implementation phases of a project.

Students working in groups or designs teams can benefit from the opportunity to learn about group dynamics and the need to

compromise; the diversity of skills and knowledge provided by members of a group; the wide variety of ideas presented by members of a group; the balanced decision-making process that takes place in groups; and the opportunity to perform the tasks for which they are not qualified. Students working as individuals can benefit from the ability to work at their own speed (which may vary considerably) on different parts of the total task; the opportunity to proceed with favourite ideas that a group might not find attractive or feasible; and the need to participate with reasonable success in all stages of the design process and its implementation. In either approach students must assume individual responsibility for the completion of required tasks.

At all levels of difficulty, projects that involve a group of students can be handled effectively by the use of the project-design approach. Process is of prime importance in this approach. Project design involves a group process, a design process, and project management. It provides a synthesis of experiences in which a group of students select, design, construct, and evaluate a project that meets specified criteria. The design experience is regulated by a series of steps that, if followed rigorously, leads to the design and production of objects, systems, or environments, along with the appropriate documentation. The thirty steps involved in this approach are listed under course content for design studies, pages 106-107.

On the completion of a full set of project-design activities by a group, each student in the group will have:

- learned how to contribute his/her best to a co-operative group exercise;
- become aware of the personal qualities and functions required of a successful group leader;
- experienced the satisfaction of having completed a project with which he/she can identify strongly;
- gained insights into him-/herself as a result of working closely with others;
- learned how to organize and maintain a relatively complex group operation;
- experienced the satisfaction that comes from doing things for others for which a real need exists.

The evaluation of student achievement in a design studies course can be particularly difficult. Assessments should reflect the individual student's success in achieving the various competencies that are essential to the design process. Although the process is more important than the product in initial design studies courses, the product tends to be the natural focus of assessment. One technique is to help students to assess their own achievements by leading them through an analysis of the functional and aesthetic aspects of their products. For reporting purposes, a profile of each student's efforts and results is often as accurate an indication of how well the

student is doing as is any other form of evaluation. Thus, students' written and oral reports and the results of their day-to-day progress should be carefully observed and recorded. Additional suggestions concerning the evaluation of student achievement in these courses are outlined on page 20 of this document. No matter what form the evaluation takes, it is imperative that students be informed of how they are being evaluated and that they be aware of the results of their efforts.

Courses in design studies are authorized for Grade 9 and for Grades 10, 11 and 12 at the basic, general, and advanced levels of difficulty. The aims and suggestions for designing these courses are provided in the sections that follow. The core content is identified for design studies courses beginning on page 100. The depth and breadth of the treatment of this core content should reflect the level of difficulty and grade at which a course is being offered. Courses may vary in time allotment and may be designed to offer up to 2 credits of in-school work each year. The Grade 11 course is a prerequisite for the Grade 12 course.

		B		B		B
Grade 9	-->	D.S.2G	-->	D.S.3G	-->	D.S.4G
		A		A		A

up to 2 credits per year

1. Grade 9 Course

Aims

Courses at this level will provide students with opportunities to develop:

- skills in using the design process;
- problem-solving skills;
- the ability to discriminate between poor and excellent design;
- techniques required to gather information and do research;
- techniques that stimulate creative thinking and idea generation;
- skills in communicating technical ideas through speaking, writing, and drawing;
- skills in planning and timing the stages of production for a design project;
- an attitude of respect and co-operation towards fellow workers and supervisors;
- a capability for critically evaluating the results of their own work, and a sense of satisfaction in a job well done;
- skills required to prepare technical reports on design projects;
- a general understanding of what it means to be a designer;
- safe work habits and procedures;
- a knowledge of career and further training opportunities in the design field.

Suggestion for Teachers

The Grade 9 course should provide opportunities for students to undertake a number of projects that involve as wide a range of core learning experiences as possible within the course time allotted. Students should acquire some perspective on the complete design process and should become creatively involved in one or more of the design stages. The core learning focuses on the design process culminating in a plan or model. The optional content in these courses should focus on the planning and implementation of the design. While the goal of initial projects may be a plan, model, mock-up, or presentation that can be communicated to others, subsequent projects may involve the construction of prototypes that require the use of optional content in the implementation of the design.

General shop safety procedures are the responsibility of every student. They should be discussed at the beginning of the course and closely followed thereafter. Special safety rules relating to specific materials, equipment, procedures, or environmental situations should be introduced at the appropriate time.

Design studies may be offered in most technological studies facilities. The ideal course organization will allow students

to use a variety of technical facilities for the design and construction of their projects. In the process a variety of specialized areas (e.g., drafting, metalwork, woodwork, physics) could be involved, as well as the particular skills and knowledge of individual teachers and students. Technological studies teachers who have an understanding of the design process should be consulted in the establishment and operation of these courses. This will be advantageous to students taking courses in both design studies and technological studies subjects in which a design project, or components of it, may be implemented.

The practical activities in courses based on this section may be conducted on an individual or a group basis. When the group approach is used, students must acquire the knowledge and skills required to function effectively in a group or a design team, as well as those necessary to function individually.

Some students may proceed to higher education in the various design fields. For this reason the recording of actions and decisions made at each stage of a project becomes an important part of student learning. The organized recording of pictorial and written data at each stage encourages student involvement, prevents students from eliminating essential steps in the design process, and is useful for project evaluation and presentation purposes.

Process is of prime importance in this course. These courses should therefore include a planned series of steps that leads to the design and production of an object or system, as well as the appropriate documentation of the project activity. Although the essential steps in the process are to be dealt with in the core learning, alternative course approaches are possible, depending on the optional content that is included.

2. Grades 10, 11 and 12

Design Studies - Basic Level
(Grades 10, 11 and 12)

Aims

All courses at the basic level will provide students with opportunities to develop:

- skills in using the design process;
- techniques required to gather information and generate ideas to support problem-solving and design activities;
- pride and self-confidence in their ability to solve problems;
- skills in working co-operatively as members of a group involved in a design activity;
- and practise safe work habits and procedures in shop activities;
- techniques for estimating material, time, and cost requirements for a project;
- their ability to use technical vocabulary in both written and spoken forms;
- communication skills, including the ability to complete drawings and make written and oral presentation;
- a general understanding of the role of designers and the qualities of a well-designed product.

Suggestions for Teachers

Basic-level courses should build on the core learning that students may have acquired in the Grade 9 design studies course. Students working at this level need opportunities to review the overall design process at each successive stage and to improve their techniques for dealing with the major stages of the process each time that they undertake a new project.

The core learning focuses on the implementation of the design process. While some projects may lead simply to a plan or a model, the opportunity to actually construct prototypes and test them is important for students. In addition to the specified core content, the planning and implementation of designs may involve optional topics that are appropriate to particular projects or objectives. These may be selected from course content outlined at the end of this guideline or from that outlined in any module in the Technological Studies guideline.

The problems and projects identified for courses at the basic level should be perceived by students as being relevant and worthwhile to them. Through learning to define problems as part of a controlled problem-solving process students' ability to recognize and identify diverse problems elsewhere can be developed. Students soon discover that there are many simple problem situations in their home and community environments

that are amenable to technological solutions. Projects that can serve the particular needs of individuals or groups in the community are particularly appropriate for the consideration of students.

Students who have acquired technical knowledge and skills over several years have the potential to implement fairly complex designs. The problems and projects undertaken by these students should therefore fully challenge them and continue to enhance their total design experience. One problem assignment could focus on the design of a product that can be mass-produced. A selection of one or more student designs could be implemented in quantity through an adaptation of mass-production methods. A shop facility, equipped to support skill development in several trade areas, is ideal for such mass production.

Some of the suggestions for teachers that are made for other design courses can be adapted for use in basic-level courses in Grades 10 to 12. It is therefore recommended that teachers refer to these sections when planning courses for the basic level of difficulty.

Design Studies - General Level

(Grades 10, 11 and 12)

Aims

All courses at the general level will provide students with opportunities to develop:

- skills in using the design process;
- further their problem-solving skills;
- a knowledge of the criteria of good design so that they can rate a commercial product;
- techniques required to gather information to support problem-solving and design studies;
- a technological perspective on alternative ways of fabricating or producing a project;
- techniques for estimating material and cost requirements for a project;
- planning and organization skills related to the production and timing of a design project;
- the safety habits and attitudes necessary for working in a variety of shop situations;
- a responsible and co-operative attitude towards the satisfactory completion of an individual or a joint undertaking;
- and further improve their skills in communicating technological ideas and information through drawn, written,

and verbal reports on projects;
- skills in working co-operatively as a member of a group involved in the solution of a design problem;
- a knowledge of career and further training opportunities in the design field.

Suggestions for Teachers

General-level courses should build on the core learning that students may have acquired in the Grade 9 design studies course. Each successive design project should challenge students, help them to acquire additional skills and knowledge related to design, and involve them creatively in the various stages of the design process.

The identification of appropriate problems is an important aspect of good planning in design studies courses. Students and other should perceive the problems undertaken in the courses as worthwhile projects that relate to personal, social, or technological needs in the community. While initial projects may be structured to develop particular skills in the overall design process, students should be involved in the selection or problems whenever possible. They should also be encouraged to identify and define problems in their home and community environments that are amenable to technological solutions. The problems undertaken should involve students in searching for information that is

pertinent to their solution and should be feasible in terms of safety considerations and the resources that are available.

Some of the suggestions for teachers that are made for other design courses can be adapted for use in general-level courses in Grades 10 to 12. It is therefore recommended that teachers refer to these sections when planning courses for the general level of difficulty.

When the project-design approach (described in the introduction to this section), is used with groups of students, the teacher must be prepared to act as a project manager for the group of students who have committed themselves to a project. As a project manager, the teacher has many functions to perform, including monitoring, guiding, evaluating, and serving as a resource person. He/she must also be competent to teach students the criteria for the selection of an appropriate project, group-process methods and techniques, design analysis, the entire design process (including research methods, creative-thinking techniques, visualizing and drawing, model and mock-up making, refinement techniques, and analysis and evaluation), and implementation techniques such as critical-path planning, management styles and techniques, technical report writing, and design presentation.

The responsibility for decision making at each step, however, must rest with the students, not with the teacher. This applies to all levels of difficulty. Without that responsibility students cease to identify themselves with the project and lose their motivation.

Teachers can modify the demand that may be placed on students in accordance with students' knowledge and competence, the time frame, and the available resources. In order for students to reach the objectives set out above, they require a minimum of three complete design-process experiences. As they become familiar with the process, they can increasingly function independently. The ultimate aim will be achieved when a group of students can direct themselves through the entire process, with the teacher only needed to monitor and evaluate their performance.

The continual evaluation of the group's progress, made at the completion of each step, is mandatory in order to assess students fairly and to maintain momentum. In addition, each individual in the group can be given assignments that reveal his/her understanding of the process. Assessments of these assignments may be used as part of students' final gradings, in combination with their group gradings. In order to ensure a sense of group responsibility, the final mark should be structured in such a way that the group activity outweighs the individual activity; otherwise, the tendency will be for

individuals within the group to seek ways of improving their status at the expense of group solidarity.

Design Studies - Advanced Level

(Grades 10, 11 and 12)

Aims

All courses at the advanced level will provide students with opportunities to develop:

- their skill and understanding in using the design process;
- further their problem-solving skills;
- a variety of techniques that can be used to gather information and to stimulate creative thinking applicable to the solution of problems;
- the management skills required for planning and scheduling the development and production stages of a project within the total time allowed;
- a knowledge of the criteria of good design so that they can rate a commercial product;
- techniques for estimating the material costs and the time requirements for a project;
- the safety habits and attitudes necessary for working safely in a variety of shop situations;
- skills in working co-operatively and responsibly as a member of a group involved in the solution of a design problem;

- skills in the writing and presentation of technical reports;
- a knowledge of career and further training opportunities in the design field.

Suggestions for Teachers

Courses at the advanced level are structured around a sequence of projects on which students work individually or in group. The design process, when carried through competently, results in a well designed process, object, system, or environment.

Depending on the strategies used to structure the projects, the learning can be quite varied. Skills related to problem solving; the design process, including creative thinking and inventiveness; information search and research; project management; prototype construction; and group process can all be part of any project. These skills should be introduced as part of the overall design process and honed and further developed with each successive project.

Many design projects require students to conduct an information search or to apply simple research procedures. Students should be encouraged to use all community resources in such activities. They can investigate the print resources available in libraries, periodicals and magazines, and the human resources available through appropriate business, industry, government, family, and other community contacts.

Since the answers that students will receive from this variety of sources can be diverse, representing a mix of abstract and practical information, the exercise of judgement is an essential part of the process. In some cases it may be necessary to develop simple survey instruments to gather and analyse opinions or other information that is required at a decision stage in the project.

Project selection is important in design studies courses. Students should perceive the projects undertaken in the courses as being worth doing from start to finish. Students are often more motivated to work on projects that they have selected themselves. Their motivation increases when their projects are to be used by a needy recipient or group. While each successive design project should challenge students, all projects cannot exceed the available resources (time, space, money, human, information). Some projects may be sponsored and thus pay for themselves. For instance, industry will sometimes propose problems to be solved and make available certain materials for students projects. Unique design solutions and inventions can lead to favourable publicity and may even be patented.

Some of the suggestions for teachers that are made for other design courses can be adapted for use in advanced level courses in Grades 10 to 12. It is therefore recommended that teachers refer to these sections when planning courses for the

advanced level of difficulty.

Elements of Technology

(Grades 9 to 12)

Four different courses may be developed in the Elements of Technology series:

Elements of Technology - Communications

Elements of Technology - Construction

Elements of Technology - Manufacturing

Elements of Technology - Transportation

Courses may be offered in Grade 9, and at all three levels of difficulty in Grades 10, 11 and 12.

Elements of Technology courses are designed to provide students with a broad based of knowledge in a particular technology. Students who wish to study a particular subject in greater depth must take the corresponding subject from the Technological Studies Guideline.

The course content for Elements of Technology subjects is listed in the Technological Studies Guideline, Part B7: Materials, Processes and Design.

PART C - CONTENT FOR DESIGN & TECHNOLOGY COURSES

Design and Technology

x Indicates "core content" for courses in the grades identified at the top of the corresponding column.

	Grades 7, 8 & 9	Grades 10, 11 & 12
Safety		
Proper control and storage of volatile and combustible fluids, glues, cements, and chemicals;	x	x
Safe and correct use, handling, and storage of materials, hand and power tools, machines, and equipment;	x	x
Proper use of safety guards and personal safety equipment;	x	x
Proper fire-prevention procedures;	x	x
Escape routes, fire extinguishers;	x	x
Awareness of potential safety hazards in the shop and the environment;	x	x
Knowledge of safe practices and the development of a positive attitude towards safety	x	x
Design		
Stating the problem; qualifying the problems;	x	x
Analysing the problem-use, appearance, economics;	x	x

Design (cont'd)	Grades 7, 8 & 9	Grades 10, 11 & 12
Alternative solutions, resources, freehand sketches, measurements, partial designs, improvement of existing designs, ergonomic considerations;	x	x
Design analysis (various commercial products)		x
Design process;	x	
Design principles;		x
Final selection--final sketch or drawing, dimensioning;	x	x
Orthographic projection, instrument drawing;		x
Interpreting drawings;		x
Bill of materials-materials list and costing;	x	x
Order of operations;	x	
Prototypes;	x	x
Careers - inventors, designers, training in design technology;	x	x
Design acronyms e.g., SAFE for Safe, Appropriate, Functional, Economic; and BASIC for Brief, Analysis, Solution, Implementation, Construction; PRAISE for Problem, Resources, Analysis, Implementation, Solution, Evaluation; SPICE for Situation, Problem,	x	x

	Grades 7, 8 & 9	Grades 10, 11 & 12
Design (cont'd)		
Investigation, Construction, Evaluation; PAGPAU for Problem as given vs Problem as understood;		
Fabrication - materials and processes		
A. Wood technology		
Identification and uses of common construction woods, processed woods;	x	
furniture woods;		x
safe and proper tool usage--measuring, layout, cutting, drilling, planing, forming;	x	x
edge tool grinding, table saw;		x
band saw, drill press;	x	
basic joining and fastening (mechanical, adhesive);	x	
joining and fastening wood--wood joints (dowel, dado, rabbet, edge-to-edge, lap and mitre), adhesive fastening (glues, clamps), mechanical fasteners, miscellaneous hardware (hinges, bolts, and catches);		x
wood turning - faceplate	x	x
- spindle		x

	Grades 7, 8 & 9	Grades 10, 11 & 12
A. Wood technology (cont'd)		
wood finishing-final surface preparation, staining, sealing, filling, top coats, polishing;	x	x
abrasive papers (types, grades, uses);	x	x
use and care of brushes, solvents;	x	x
various finishing materials;	x	x
related occupational and career information.	x	x
B. Metal technology		
Introduction to metal-working processes in industry and the shop;	x	x
metal industries and related careers;	x	x
stock types-bar, band, sheet;	x	x
identification of ferrous and non-ferrous metals;	x	x
methods of manufacturing steel, copper, aluminium;		x
steel--structure and properties, annealing, tempering;		x
ornamental ironwork--design, forming, fastening (rivets, welds), surface treatment;		x

	Grades 7, 8 & 9	Grades 10, 11 & 12
B. <u>Metal technology</u> (cont'd)		
metal turning--end facing, parallel turning, short tapers, knurling, drilling, filling,polishing, use of micrometer;		x
oxy-acetylene fundamentals--proper regulator and torch adjustments, types of flames, flashback and backfire, tip selection, brazing techniques;		x
spot welding--safety and control;		x
metal fastening--tap and die, threaded fasteners, rivets;		x
metal finishing--buffing, wire brushing, etching, surface coating;	x	
methods of layout--measurement, marking and transfer techniques;	x	x
sheet metal--cutting, filing, use of metalworking hand tools, folding (brake), roll forming, fastening, soldering and finishing.	x	x
C. <u>Plastics technology</u>		
Identification and general classifications of common plastics;	x	x
acrylics, thermoforming plastics;	x	x
thermosetting plastics, fibreglass;		x
industrial production of plastics;		x

	Grades 7, 8 & 9	Grades 10, 11 & 12
C. Plastics technology (cont'd)		
Processes--layout, cutting, measuring, simple thermoforming (heating, bending, forming);	x	x
fastening mechanically (drilling, tapping, threading);	x	x
use of bonding agents;	x	x
casting (molds, finishing, polishing, buffing);	x	x
transferring patterns; laminating, turning on lathe, sawing, dressing plastic edges;	x	x
surface decorating--engraving, veining, colouring;		x
fibre glassing--materials, molds, attaching material to the mold, mixing and applying resin, finishing;		x
careers in the plastic industry.	x	x

Engineering - Power and control technology

A. Power and energy

	Grades 7, 8 & 9	Grades 10, 11 & 12
the relationship of power and energy to work		x
forms of energy;	x	x
conservation of energy;	x	x
springs;		x
power transmission (drives, belts, gears, mechanical kits);	x	x

	Grades 7, 8 & 9	Grades 10, 11 & 12
A. <u>Power and energy</u> (cont'd)		
drive shafts, universals, pulleys;	x	x
measurement of energy consumption;		x
internal combustion engines (energy transformation);		
spark and compression ignition;		x
external combustion engines (steam);		
characteristics and principles of fluid power (hydraulics and pneumatics), simple fluid power circuits (hydraulic jack);		x
applications of fluid power to production and control.		x
B. <u>Power transmission (mechanisms)</u>		
general terms - definitions of force, force unit, mechanical advantage, velocity ratio, efficiency;	x	x
types of motion (linear, rotary, oscillating, reciprocating);	x	x
Newton's laws of motion - First law, Third law;		x
levers and linkages - types of levers, moments of forces, linkage systems;	x	
pulleys, belts, sprockets and chains - types and applications of pulleys wheels; pulley systems (direction change, speed	x	

	Grades 7, 8 & 9	Grades 10, 11 & 12
B. <u>Power transmission</u> (cont'd)		
change);		
gears - spur gear, gear train (including the determination of driver and driven rotation speeds and direction of driver and driven);	x	
cams, eccentrics, and ratchets - cams and followers, ratchet and pawl mechanisms, applications;		x
crank, slider, and screw mechanisms-inclined planes, screw mechanisms applications, terms (thread, pitch, and vee, square, and buttress thread shapes) use of crank for rotary to linear motion); crank and slider mechanisms;		x
clutches and brakes - single plate friction clutch, dog clutch, centrifugal clutch, pad, shoe, disc, and band brakes; hydraulic brakes; brake and clutch materials		x
lubrication - function of lubricating oil and methods of oil distribution; oil viscosity and temperature;		x
bearings - types, applications;		x
steering - types; Ackerman angle; castor angle, camber angle;		x

C. <u>Electricity and electronics</u>	Grades 7, 8 & 9	Grades 10, 11 & 12
Sources of electrical energy;	x	x
electrical circuits (electrical source, conductors, insulators, control switches, resistors, fuses);	x	
electrical devices for energy transformation;		x
loads;		x
electromagnetism;		x
simple electromagnetic circuits (bells, buzzers, relays solenoids);	x	
schematics and hook-up diagrams;		x
control circuits;		x
electrical motors;	x	x
lighting circuits;	x	x
safety requirements;	x	x
test instruments;		x
interface systems and robotics;		x
simple electronic circuits, systems and kits;	x	x
related occupational and career information.	x	x

	Grades 7, 8 & 9	Grades 10, 11 & 12
<u>Construction Technology</u>		
A. <u>Building construction</u>		
Safety on the construction site;		x
layout of structures;		x
woodworking materials and processes (truing rough lumber by hand and by machine, joining and fastening wood).		x
<u>Structures</u>		
Examples of common structures (buildings, furniture cranes, bridges);	x	x
structures in nature;	x	
joints - joining solid and hollow materials in stressed furniture;		x
reinforcing at joints; force transfer at a joint;		x
design requirements of a structure (structure stability, foundation anchoring, flexibility, safety factor, stiffness and rigidity); effect of length of structural member, material, and shape of cross-section on performance strength, stiffness, and weight; testing of structures and models.		x

B. Home maintenance	Grades 7, 8 & 9	Grades 10, 11 & 12
Woodwork tasks--drawer repair, removing finish from wood, refinishing furniture;		x
--designing furniture to a known style or period;		x
electrical tasks--replacing or repairing an appliance cord, wiring a desk or table lamp;		x
--wiring home monitoring systems - intercoms, alarms, etc.		x
plumbing tasks--repairing a leaky water faucet;		x
--planning auxiliary systems - softeners, purifiers, etc.		x
mechanical tasks--making minor adjustments on small gasoline engines, sharpening tools;		x
electro-mechanical tasks--installation of garage door openers, ramps or lifts for physically handicapped persons, etc.		x

Design Studies

x Indicates "core content" for courses in the grades identified at the top of the corresponding column.

	Grade 9	Grades 10, 11 & 12
Safety		
Proper control and storage of volatile and combustible fluids, glues, cements, and chemicals;	x	x
safe and correct use, handling, and storage of materials, tools, machines, and equipment;	x	x
proper use of knowledge of safety guards and personal safety equipment;	x	x
proper fire-control procedures; escape routes, fire extinguishers;	x	x
awareness of potential safety hazards in the shop and the environment;	x	x
knowledge of safe practices and the development of a positive attitude towards safety.	x	x
Role of the designer in society		
The role of the professional designer in the development of a new product for the market;		x

	Grade 9	Grades 10, 11 & 12
<u>Role of the designer in society</u> (cont'd)		
the nature of industrial design, engineering design, graphic design, interior design, fashion design, theatre design, or craft design;	x	x
the economic importance of excellent product design;	x	x
the historical perspective on the role of the designer;		x
career opportunities and training paths in design.	x	x
<u>Design analysis</u>		
The analysis of existing hardware in order to develop discrimination in design by the application of criteria such as simplicity, efficiency, optimum use of materials, ergonomics, aesthetics, safety;	x	
plus reliability, serviceability and performance per dollar;		x
criteria weighting;		x
systematic comparison of commercial items;	x	x
learning to become an intelligent consumer.	x	x

	Grade 9	Grades 10, 11 & 12
<u>The design process</u>		
The structured series of decision-making steps involved in every design activity -- problem definition, constraints, performance, identification, specifications, research methods, generation of possible solutions, evaluation factors, selection of the "best" solution, refinement of the solution, analysis, implementation, report, and presentation.	x	x
A. <u>The problem stage</u>		
Defining the problem clearly and concisely;	x	x
identify the relevant factors involved or associated with the problem;	x	x
establishing criteria for requirements, restrictions, resources, and evaluation;	x	x
obtaining the required information (facts, and knowledge about the factors).	x	x
<u>Research methods</u>		
Using total community resources for the purpose of gathering information;	x	x
developing interviewing skills;		x

	Grade 9	Grades 10, 11 & 12
<u>Research methods</u> (cont'd)		
recording data;	x	x
conducting a library search;		x
discriminating relevant data;	x	x
analysing statistics;		x
designing research to establish validity;		x
using computer generated data.		x
B. <u>The creative stage</u>		
Using: - techniques of imaginative thinking;	x	x
- awareness exercises;	x	x
- psychological conditioning techniques;		x
Generating possible solutions to a problem by:		
- employing Osbornes' rules		x
- systematic manipulation of variables to produce novel ideas (morphological chart);	x	x
- brainstorming;	x	x
- using lateral thinking techniques;		x
- using manipulative verbs;		x
- visualizing and drawing;	x	x
- collating ideas;	x	x
- letting the evaluation of possible solutions lead to other possible solutions;	x	x
- computer modelling.		x

	Grade 9	Grades 10, 11 & 12
C. <u>The develop-to-the-optimum stage</u>		
By: - selecting a tentative solution;	x	x
- testing the solution and assessing the results;	x	x
- revising and refining through: graphic communications;	x	x
models and mock-ups.	x	x
D. <u>Implementation of the design</u>		
Through:		
- working drawings;	x	x
- technical illustrations and renderings;	x	x
- prototypes.	x	x
E. <u>Technical reporting and presentation</u>		
By: - planning and recording activities;	x	x
- using graphic communication;	x	x
- using reproduction methods for technical drawings;	x	x
- documenting achievements;	x	x
- organizing written, oral, graphic, and demonstration material for presentation;	x	x
- compiling a technical report.	x	x

	Grade 9	Grades 10, 11 & 12
Project management		
The effective deployment of human and material resources to reach a defined goal-- preparation and execution of plans for simple projects using appropriate design criteria and graphic communications techniques;		x
correct interpretation of plans and specifications;		x
project-management concepts;		x
leadership and motivation;		x
scheduling methods;		x
legal and costing considerations.		x
Group process		
Selection of partners;	x	x
team-forming techniques;	x	x
stating agreed-upon goals;	x	x
group task and group maintenance;	x	x
monitoring progress;	x	x
evaluation methods.	x	x

Thirty steps for regulating a group process in project design

Phase I: Initiation

Students:

1. search for and select a suitable project;
2. selection partners to work with;
3. search for information that is pertinent to the solution;
4. make a personal commitment to the project.

Phase II: Design

Students:

5. complete a project description;
6. list any constraint to the project;
7. gather information and documentation;
8. outline performance specifications;
9. generate a number of possible solutions to the problem outlined;
10. evaluate the factors involved;
11. select a solution(s);
12. refine the solution(s);
13. finalize the solution(s);
14. evaluate the finalized design;
15. evaluation the group process.

Phase III: Implementation

Students:

16. schedule their project;
17. produce formal drawings or photographs;
18. complete a prototype, object, or system;
19. testing and evaluate their product;
20. make any necessary modifications to their product;
21. evaluate the performance of their group.

Phase IV: Report

Students:

22. summarize what took place in the previous three phases;
23. make a final evaluation of the performance of their product;
24. make a final evaluation of the performance of their group;
25. draw conclusions on the basis of their experience;
26. make recommendations on the basis of their experience;
27. compile a bibliography of the documentation that they used;
28. list any resources (both material or human) that were involved in the project;
29. compile their documentation in printable form;
30. present their report and demonstrate their product.

ACKNOWLEDGEMENTS

The Ministry of Education wishes to acknowledge the contributions of the many persons who participated in the development of the Design & Technology curriculum guideline.

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